AMENDMENTS TO THE SPECIFICATION

Please amend the paragraph beginning on page 1, line 1 as follows:

~~DESCRIPTION~~

Please insert the following paragraph on page 1 after the title:

CROSS REFERENCE TO RELATED APPLICATIONS

The present application is a national stage of PCT/JP2004/015901, filed October 27, 2004, which claims priority to Japanese application No. 2003-427865, filed December 24, 2003.

Please amend the paragraph beginning on page 1, line 4 as follows:

~~Technical~~ Field of the Invention

Please amend the paragraph beginning on page 1, line 10 as follows:

Background ~~Art~~ of the invention

Please amend the paragraph beginning on page 1, line 11 as follows:

In radio communication systems such as portable telephones, etc., using the microwave band or the millimeter wave band, dielectric resonators are used in the filters and the oscillators in ~~the~~ these systems. ~~Then, a~~ A TE01 δ-mode dielectric resonator is used in applications where high Q and high power resistance are required. In the TE01 δ-mode dielectric resonator, a cylindrical or polygonal dielectric resonance element is held on a support. In order to connect the resonator to an outer circuit, an input-output electrode such as a microstrip line, a metal probe, etc., is required on a substrate for mounting the resonator. Here, in order to obtain desired electric characteristics of the device, it is required to set the amount of coupling to the outer circuit, which changes by the distance between the input-output electrode and the resonator, etc., to a desired value. In order to obtain a coupling to an outer circuit in the TE01 δ-mode dielectric resonator, the following ~~method has~~ methods have been proposed.

Please amend the paragraph beginning on page 2, line 6 as follows:

In Japanese Unexamined Patent Application Publication No. 5-152845 (Patent Document 1), input-output electrodes of microstrip lines are disposed so as to sandwich a dielectric support where a TE01 δ-mode dielectric resonator is used in microwave band oscillators ~~is set~~.

Please amend the paragraph beginning on page 2, line 10 as follows:

Furthermore, in Japanese Unexamined Patent Application Publication No. 2-246403 (Patent Document 2), in order to increase a coupling to an outer circuit, a high-frequency oscillator ~~in which~~ has a TE01 δ-mode dielectric resonance element which is disposed on a support so as to be tilted. In this way, when an input-output electrode is disposed on the side where the resonance element is downward tilted, the coupling to an outer circuit can be increased. Furthermore, since the input-output electrode can be disposed at a location away from the support, the fear that the support may be set on the input-output electrode is reduced and also the possibility that oscillation characteristics may become unstable can be decreased.

Please amend the paragraph beginning on page 2, line 23 as follows:

~~Patent Document 1: Japanese Unexamined Patent Application Publication No. 5-152845~~

Please amend the paragraph beginning on page 2, line 25 as follows:

~~Patent Document 2: Japanese Unexamined Patent Application Publication No. 2-246403~~

Please amend the paragraph beginning on page 2, line 2 as follows:

~~Disclosure of Invention~~

Please amend the paragraph beginning on page 2, line 3 as follows:

~~Problems to be Solved by the Invention~~

Please insert the following prior to the paragraph beginning on page 5, line 1:

Summary of the Invention

Please amend the paragraph beginning on page 5, line 1 as follows:

As described above, in the above two patent documents, although the resonator and the input-output electrode can be strongly coupled, there occurs a problem in that the characteristics deteriorate due to the mounting accuracy and the use of the resonator is limited. ~~Then~~ Thus, it is an object of the present invention to obtain a TE01 δ-mode dielectric resonator in which, even if an input-output electrode is away from the resonator, a strong coupling to an outer circuit can be obtained and resonator characteristics do not change because of mounting accuracy of the resonator, to obtain a filter, duplexer, oscillator, etc., using the resonator, and to obtain a communication device using these.

Please amend the paragraph beginning on page 5, line 15 as follows:

~~Means for Solving the Problems~~

Please amend the paragraph beginning on page 6, line 5 as follows:

Because of the structure, since the magnetic field of the dielectric resonance element spreads out to the tilted portion of the side face at the outer periphery of the protrusion portion and its vicinity, the spread of the magnetic field distribution can be ~~more~~ greatly increased around the lower portion of the dielectric resonance element as compared to ~~than in the~~ related structures. Thus, even if an input-output electrode is disposed at a location away from the protrusion portion, the dielectric resonance element can be strongly coupled to the input-output electrode. Therefore, since the protrusion portion is made not to contact ~~with~~ the input-output electrode, resonator characteristics do not change.

Please amend the paragraph beginning on page 6, line 19 as follows:

Furthermore, when the side face at the outer periphery of the protrusion portion is not tilted, a step portion substantially perpendicular to each other is formed at the boundary between the dielectric resonance element and the protrusion portion. When ~~these~~ the dielectric resonance element and protrusion portion are integrally formed by press molding, the mold density drastically changes at the boundary and the molding cannot be stably performed. However, since the step portion has a slope at the boundary between the dielectric resonance element and the protrusion portion such that the side face at the outer boundary of the protrusion portion is tilted, the drastic change of the mold density is lessened and ~~it becomes able to perform a~~ stable molding can be performed. Furthermore, because of such a structure, ~~it becomes able to use~~ an easy and low-cost one-axis press molding can be used.

Please amend the paragraph beginning on page 7, line 20 as follows:

Moreover, according to the present invention, the area of the bottom surface of the dielectric resonance element is larger than the area ~~on~~ of the bottom-surface side of the dielectric resonance element of the protrusion portion. When constructed in this way, a ring-shaped flat portion can be formed at the edge portion of the bottom surface of the dielectric resonance element. In the TE01 δ-mode dielectric resonator of the present invention, the dielectric resonance element and the protrusion portion are integrally formed by using a molding die. Sharp portions in the molding die are eliminated such that a flat portion is ~~provide~~ provided on the bottom surface of the dielectric resonance element as in the present invention, and as a result, the durability and wear resistance of the molding die are improved.

Please amend the paragraph beginning on page 8, line 19 as follows:

Furthermore, when a duplexer is produced by using a filter using a TE01 δ-mode dielectric resonator of the present invention, even if a strong coupling is required between the resonators and the input-output electrodes of the transmission-side circuit, the

reception-side circuit, and the antenna, since the change of resonator characteristics due to mounting accuracy does not occur, desired duplexer characteristics can be obtained.

Please amend the paragraph beginning on page 9, line 8 as follows:

~~Advantages~~

Please amend the paragraph beginning on page 10, line 18 as follows:

~~Fig. 4~~ Figs. 4A through 4E are ~~is a~~ schematic sectional ~~view~~ views of alternate embodiments of ~~where, in the TE01 δ-mode dielectric resonator according to an embodiment of the present invention,~~ the shape of the tilted side face at the outer periphery of the protrusion portion ~~is altered~~.

Please amend the paragraph beginning on page 10, line 23 as follows:

~~Fig. 5 is a~~ Figs. 5A and 5B are schematic sectional ~~view~~ views of embodiments where a hollow or a hollow with a tilted side face ~~is~~ are provided in the TE01 δ-mode dielectric resonator ~~according to an embodiment of the present invention~~.

Please amend the paragraph beginning on page 12, line 22 as follows:

~~Best Mode for Carrying Out the Invention~~ Detailed Description of the Preferred Embodiments of the Invention

Please amend the paragraph beginning on page 12, line 23 as follows:

Hereinafter, a first embodiment of the present invention is described with reference to the drawings. Fig. 1 is a schematic sectional view of a TE01 δ-mode dielectric resonator 1 according to an embodiment of the present invention. In Fig. 1, a dielectric resonance element 2 is cylindrical, a protrusion portion 3 is disposed on the bottom-surface side of the dielectric resonance element 2 in an axial direction perpendicular to the bottom surface, and the section of the protrusion portion 3 is also circular. Regarding the preferred dimensions of the TE01 δ-mode dielectric resonator 1 according to the embodiment, the diameter 6 of the bottom surface of the dielectric resonance element 2 is

preferably 5.6 mm, the thickness of the dielectric resonance element 2 is preferably 2.5 mm, the diameter 5 of the surface on the dielectric-resonance-element side of the protrusion portion 3 is preferably 4 mm, the diameter 4 of the lower surface of the protrusion portion 3 is preferably 3.2 mm, and the thickness of the protrusion portion 3 is preferably 1 mm. Thus, a tilted side face is provided at the outer periphery of the protrusion portion 3 such that the area (diameter 5) on the bottom-surface side of the dielectric resonance element 2 of the protrusion portion 3 is made larger than the area (diameter 4) of the lower surface of the protrusion portion 3. Furthermore, a ring-shaped flat portion is formed in the edge portion of the bottom surface of the dielectric resonance element 2 such that the area (diameter 6) of the bottom surface of the dielectric resonance element 2 is made larger than the area (diameter 5) of the surface on the bottom-surface side of the dielectric resonance element 2 of the protrusion portion 3. The dielectric resonator 1 is preferably ~~used such that the dielectric resonator 1 is~~ glued and fixed on a mounting substrate 9 such as a glass-epoxy substrate, etc., ~~where~~ having an input-output electrode 8 of a microstrip line using copper wiring, etc., and ~~that~~ the dielectric resonator 1 is covered by a cavity case 10. Moreover, the cavity case 10 is preferably a metal case or a conductive case where a conductive material is coated on ceramics.

Please amend the paragraph beginning on page 14, line 14 as follows:

Furthermore, the dielectric resonance element 2 and the protrusion portion 3 are preferably integrally formed by press molding using a dielectric material. The dielectric material of the resonator 1 used in the present embodiment is preferably a zirconium titanate-tin titanate compound and has a dielectric constant of 38.

Please amend the paragraph beginning on page 14, line 20 as follows:

In the structure of the present embodiment, as shown in Fig. 1, an arbitrary point 11 at the outer periphery on the lower surface of the protrusion portion 3 of the TE01 δ-mode dielectric resonator 1 was set as a datum point, and, when a distance 14 was changed so as to be away from the arbitrary point 11, the change of the magnetic field strength was ~~sought~~ evaluated by performing a simulation. The result is shown in Fig. 2. Moreover,

the magnetic field distribution of the TE01 δ-mode dielectric resonator 1 is ~~as~~ shown by reference numeral 12 in Fig. 1. Furthermore, the angles shown in Fig. 2 indicate the tilted angle 13 of the side face 7 of the protrusion portion 3 shown in Fig. 1. In this graph, the magnetic field strength at the datum point when the tilted angle 13 is zero degree, that is, when the protrusion portion 3 has no tilted side face, ~~is set~~ was used as a reference, and the magnetic field strength when the distance 14 is changed is represented by a ratio to the reference value. Moreover, a schematic sectional view of a resonator of a related structure where the protrusion portion has no tilted side face is shown in Fig. 11. In the graph, the change of the magnetic field strength when the tilted angle 13 in Fig. 1 is changed is also shown.

Please amend the paragraph beginning on page 17, line 3 as follows:

Furthermore, it is understood that the larger the tilted angle 13 shown in Fig. 1 is, the farther from the datum point 11 the location where the same magnetic field strength can be obtained is. This is because the magnetic field of the dielectric resonance element 2 largely spreads to the tilted portion 7 and the area under the tilted portion 7 ~~such that~~ when, as shown in Fig. 1, the protrusion portion 3 is made to have a tilted side face. As a result, it is understood that desired resonator characteristics can be obtained regardless of the mounting accuracy of the TE01 δ-mode dielectric resonator such that the tilted angle 13 which is preferably not less tan 20 degrees where characteristics deterioration due to resonator mounting accuracy is not caused and preferably less than 90 degrees where no problem is caused by the resonator structure is chosen.

Please amend the paragraph beginning on page 17, line 20 as follows:

Moreover, the dielectric material for the TE01 δ-mode dielectric resonator according to the present embodiment may be chosen from a group of a rare earth barium titanate compound, barium titanate compound, zinc barium tantalate compound, magnesium barium tantalate compound, rare earth aluminate-barium titanate compound, magnesium titanate-calcium titanate compound, zinc calcium niobate compound, ~~and~~ cobalt zinc barium niobate compound, and zirconium titanate-tin titanate compound

~~except for the material of the present embodiment~~ in accordance with frequency bands, etc., in the specifications of resonators. Moreover, the dielectric constant of the dielectric materials at this time is in the range of 20 to 130. Furthermore, the dielectric resonance element 2 and the protrusion portion 3 are not limited to be cylindrical in shape, but also may be polygonal pole-shaped. Moreover, the input-output electrode shown in Fig. 1 is a microstrip line, but the same effect can be obtained by using a metal probe, etc., in addition to other flat lines such as a coplanar line, etc.

Please amend the paragraph beginning on page 18, line 22 as follows:

As described above, the magnetic field distribution can be largely spread to the tilted portion at the outer periphery of the protrusion portion and the area under the tilted portion such that the side face of the protrusion portion is tilted, when compared with the related structure having no tilted portion. In this way, even if the input-output electrode is separated from the protrusion portion, a strong coupling to an outer circuit can be obtained and a TE01 δ-mode dielectric resonator in which resonator characteristics are not changed because of the affect of mounting accuracy of the dielectric resonator ~~can be obtained~~.

Please amend the paragraph beginning on page 19, line 10 as follows:

Fig. 3 is a schematic sectional view of a molding die used ~~when~~ to form the TE01 δ-mode dielectric resonator according to ~~a~~ the first embodiment~~, is integrally molded~~ and of a resonator at the molding. As shown in Fig. 3, in the molding die when the TE01 δ-mode dielectric resonator is integrally molded, a die 21a/21b, a first punch 22, and a second punch 23 are ~~required~~ used. In the TE01 δ-mode dielectric resonator of the present invention, as shown in Fig. 3, a ring-shaped flat portion 24 is provided at the edge portion of the bottom surface of the dielectric resonance element. Therefore, no portion of a weak strength such as a sharp-edged portion, etc., is required in each molding die, and the durability and wear resistance of the die can be improved.

Please amend the paragraph beginning on page 20, line 1 as follows:

~~Fig. 4 is~~ Figs. 4A through 4E are a schematic sectional ~~view~~ views of alternate embodiments ~~where~~ of the tilted surfaces provided at the outer periphery of the protrusion portion of the TE01 δ-mode dielectric resonator of the present invention ~~of the first embodiment is altered in shape~~. Regarding the shape ~~31~~ of the tilted surface 31 at the outer periphery of the protrusion portion, various shapes ~~as shown in Fig. 4~~ can be ~~expected~~ formed in consideration of the ease of molding the dielectric resonator 30, a desired coupling to an outer circuit, the mounting accuracy of the dielectric resonator, etc. In ~~(a) of~~ Fig. 4A, the tilted side face 31a of the protrusion portion is outward circular arc-shaped; in ~~(b) of~~ Fig. 4B, the tilted side face 31b of the protrusion portion is in a straight line; and in ~~(c) of~~ Fig. 4C, the tilted surface of the protrusion portion 31c is inward circular arc-shaped. When, except for the tilted portion, the structure is the same and the input-output electrode is disposed at the same location from the outer periphery of the lower surface of the protrusion portion, the magnetic field strength at the input-output electrode is in the order of ~~(a), (b), and (c) of Fig. 4~~ Fig. 4A, Fig. 4B and Fig. 4c, and the magnetic field strength can be adjusted by changing the shape of the tilted side face. Furthermore, in ~~(d) of~~ Fig. 4D, a ting-shaped flat portion 32d is provided at the edge portion of the bottom surface of the dielectric resonance element. Thus, the magnetic field distribution can be spread to the area under the tapered portion and the durability and wear resistance of the molding die can be increased. Furthermore, in ~~(e) of~~ Fig. 4E, the boundary portion between the flat portion 32e at the edge of the bottom surface of the dielectric resonance element and the protrusion portion 31e is made circular arc-shaped. Because of such a structure, since the molding die is also made circular arc-shaped, its durability and wear resistance is further improved.

Please amend the paragraph beginning on page 21, line 13 as follows:

In ~~Fig. 5~~ Figs. 5A and 5B, a hollow is provided in the protrusion portion of ~~the~~ a TE01 δ-mode dielectric resonator ~~according to the first embodiment~~ of the present invention. There are cases where a hollow is required in the protrusion portion for reasons of the manufacturing and mounting processes of dielectric resonators and for obtaining

desired resonator characteristics. Even in such a case, the same effect as in the first embodiment can be obtained such that, as shown in ~~(a) of~~ Fig. 5A, a tilted side face 41a is provided at the outer periphery of the protrusion portion 42a. Furthermore, one-axis press molding as an easy and low-cost molding method can be easily performed such that, as shown in ~~(b) of~~ Fig. 5B, the side face of the hollow in the protrusion portion 42b has a tilted surface.

Please amend the paragraph beginning on page 22, line 3 as follows:

In Fig. 6, an adjustment hole 52 is provided in a resonator 50 in a direction perpendicular to the upper surface of the resonator for adjustment of the resonance frequency of the TE01 δ-mode dielectric resonator of the present invention ~~according to the first embodiment~~. A screw or the like is inserted into the adjustment hole 52 and the resonance frequency is adjusted in accordance with the amount of insertion. Also in such a structure, the same effect as in the first embodiment can be obtained such that the side face at the outer periphery of the protrusion portion has a tilted surface 51.

Please amend the paragraph beginning on page 23, line 9 as follows:

Fig. 8 is a schematic sectional view of an embodiment of a duplexer using the TE01 δ-mode dielectric resonator of the present invention ~~embodiment~~. In Fig. 8, three TE01 δ-mode dielectric resonators 70 constituting a reception filter 76 and two TE01 δ-mode dielectric resonators 70 constituting a transmission filter 77 are disposed inside a cavity case 74. Coaxial connectors 71 in Fig. 8 are used as input-output terminals of the reception filter 76 and the transmission filter 77, and a common coaxial connector 72 is used as an antenna input-output terminal for inputting and outputting to the transmission and reception filters. At the tip of each coaxial connector, an input-output electrode (metal probe) 73 is attached for electromagnetic coupling to the resonator 70. Each resonator 70 is fixed such that the lower surface of the protrusion portion is glued to the cavity case 74 using an adhesive, etc. An adjustment screw 75 for adjusting the resonance frequency is provided above each resonator 70. The cavity case 74 is made up of a metal case or a conductive case where a conductive material is coated on the surface of ceramics.

Moreover, the number of resonators constituting the filters is not limited to the above numbers in order to obtain desired filter characteristics.

Please amend the paragraph beginning on page 25, line 13 as follows:

Fig. 10 shows one embodiment of a transmission-reception circuit of a communication device using the TE01 δ-mode dielectric resonator of the present invention ~~first embodiment~~. A transmission-side signal is processed in the following way. A transmission-side signal 93 is frequency-converted using a signal of a local oscillator 90 input to a mixer 92 through a frequency divider 91. Next, frequency components outside a transmission frequency band of a transmission-side signal are eliminated by a bandpass filter 94. After that, the transmission-side signal is amplified by an amplifier 95 and transmitted from an antenna 99 through a transmission-side filter 97 of a duplexer 96. Furthermore, a reception-side signal is processed in the following way. A reception-side signal received from the antenna 99 is output to a reception-side circuit through a reception-side filter 98 of the duplexer 96. Frequency components outside a reception frequency band in the signal are eliminated by a bandpass filter 100 and amplified by an amplifier 101. After that, the reception signal is frequency-converted to a frequency lower than the reception signal at a mixer 102 by using a frequency signal of the local oscillator 90 output from a bandpass filter 103, and an intermediate frequency 104 signal is output. In the circuit, the filter and duplexer shown in the above embodiments are used in the bandpass filter 94 for transmission, the bandpass filter 100 for reception, and the duplexer 96. Moreover, the TE01 δ-mode dielectric resonator of the present invention is used in the oscillator 90.